

# Recent Advances in BioMedical Telemetry

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**Abstract** – Communication systems for implantable medical devices are rapidly advancing. Cardiac, optical, neurological and auditory devices all utilize this technology. Miniaturized antennas and inductive coupling systems provide the radio interface between air and the implantable device. Miniaturized electronics that can be seamlessly integrated with the medical device provide electrical and communication interfaces. Power transfer (“link budget”) and deposition (SAR) issues continue to be explored and better understood. This paper describes recent advances in each of these system components. The challenges of miniature biocompatible packaging, patient variability, and utilization of new materials will be discussed.

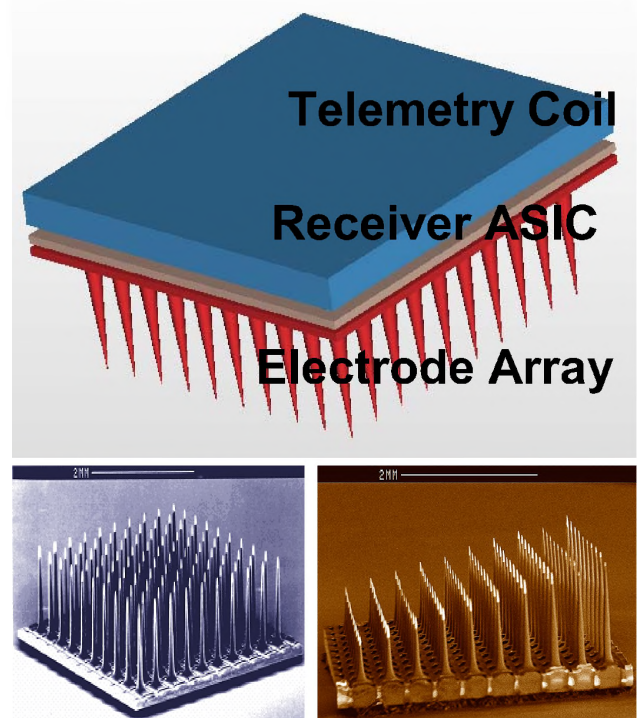
## 1 INTRODUCTION

Wireless telemetry systems that communicate with implantable medical devices such as cardiac pacemakers and defibrillators, [1] neural recording and stimulation devices, [2] and cochlear [3] and retinal [4] implants are becoming more and more common. Today’s systems most often use inductive transmission for both transmitting data and recharging the implanted electronics, but improvements in ultralow power transceiver design are enabling devices that transmit higher data rates and longer distances. Antennas for imbedded applications must be small and long term biocompatible. Emerging medical telemetry devices have led to recent advances in the design of small, biocompatible antennas that can be implanted in the human body. The absorption of the fields by the body limits the distance that an external transceiver can be placed from the body. If the power is increased, battery life suffers, and the device may exceed regulations for maximum power absorption (specific absorption rate – SAR) in the body.

Implantable medical devices utilize the Medical Implant Communication Service (MICS) band from 402-405 MHz. The maximum bandwidth that can be used by a single device is 300 kHz in this band, and the range is typically 2 meters. The maximum power limit is 25  $\mu$ W Equivalent Radiated Power (ERP), and the system is required to use clear-channel assessment, where the external device scans all 10 of the MICS channels and chooses the lowest noise channel.

## 2 TRANSCEIVER ARCHITECTURES

Several experimental transceiver architectures have been developed over the past decade, some of which are now becoming commercially viable. Chip rates on the order of 20 kbps are desired at distances of 2 meters using low power, very small electronics. Devices may achieve this performance by spending most of their time in an ultra-efficient sleep mode followed by short bursts of data transmission activity, by using data mining or compression strategies to reduce the actual bits of data to be transmitted, or by improved design of the hardware. One such design integrates electrodes for neural recording with the transceiver in a flip-chip bonded package, thus eliminating all wires between the medical device and transceiver unit, shown in Figure 1. [5]



**Figure 1 Utah Electrode Array packaged with a custom ASIC and printed receiver coil (From [14] © 1999 )**

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### 3 INDUCTIVE COUPLING

In the majority of implantable wireless telemetry devices, inductively coupled coils transmit data and if necessary transmit enough power to recharge the battery in the implantable device. These coils are often wound around a dielectric or ferrite core to improve the efficiency of transmission. Frequencies are often lower than 50 MHz to ensure that the presence of the human body does not significantly obstruct the coupling between the coils. [6]

Most inductive telemetry links are used for subcutaneous applications due to power restrictions for passive devices. Data rates are generally low, and size/weight and biocompatibility issues plague these devices, however recent advances continue to reduce the power requirements and provide more biocompatible designs.

### 4 HIGHER FREQUENCY TRANSMISSION SYSTEMS

Higher frequency telemetry links are also being developed for medical implants. For cardiac telemetry, a dipole [7] and spiral or serpentine microstrip [8-9], circumferential [10], and a waffle-type design [11] have been designed for implantation in the shoulder. An insulated wire antenna has also been used, and this wire may be used as the lead between the heart and the battery pack/controls of the pacemaker. [10]

For smaller implants, a microstrip patch antenna has been successfully used for a retinal prosthesis [12], and a small dipole has been designed for communication with a brain implant. [13]

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